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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/988,685	11/20/2001	Yoshimi Shioya		9020

7590 03/12/2003
LORUSSO & LOUD
3137 Mount Vernon Avenue
Alexandria, VA 22305

EXAMINER

HOGANS, DAVID L

ART UNIT	PAPER NUMBER
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2813

DATE MAILED: 03/12/2003

11

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

09/988,685

Applicant(s)

SHIOYA ET AL.

Examiner

David L. Hogans

Art Unit

2813

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 02 December 2002.
- 2a) ☒ This action is **FINAL**. 2b) ☐ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1,3-8,12,13 and 26 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1,3-8,12,13 and 26 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on 20 November 2001 is/are: a) ☒ accepted or b) ☐ objected to by the Examiner.
- Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- 11) ☐ The proposed drawing correction filed on _____ is: a) ☐ approved b) ☐ disapproved by the Examiner.
- If approved, corrected drawings are required in reply to this Office action.
- 12) ☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

- 13) ☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☒ All b) ☐ Some * c) ☐ None of:
1. ☒ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- * See the attached detailed Office action for a list of the certified copies not received.
- 14) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).
- a) ☐ The translation of the foreign language provisional application has been received.
- 15) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____.
- 4) ☐ Interview Summary (PTO-413) Paper No(s). _____.
- 5) ☐ Notice of Informal Patent Application (PTO-152)
- 6) ☐ Other:

DETAILED ACTION

This Office Action is in response to Amendment B filed on December 12, 2002.

Status of Claims

Claims 1, 3-8, 12-13 and 26 are pending. Claims 2, 9-11 and 14-25 are cancelled.

Specification

1. The abstract of the disclosure is objected to because line 1 of the amended abstract states "A process gas **containing** any one of ...". As "containing" is synonymous with "comprising", it does not reflect the scope of the patent because the specification supports "A process gas **consisting of** ...". The scope of the patent supports a closed ended grouping and not an open ended grouping. See MPEP § 2111.03. Correction is required. See MPEP § 608.01(b).
2. The substitute specification submitted on December 2, 2002, has been entered.

Claim Rejections - 35 USC § 102

3. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

4. Claims 1, 6 and 13 are rejected under 35 U.S.C. 102(e) as being anticipated by 6,335,283 to Ngo et al.

In reference to Claims 1, 6 and 13, Ngo et al. teaches:

- nitriding of a copper surface by a nitrogen plasma to convert the surface layer portion into a copper diffusion preventing layer and then placing a silicon containing insulating film (i.e. – SiN) over the nitrided copper layer. (See columns 5-6 lines 40-20 and column 6 lines 42-57) The Examiner notes that Applicant only claims that exposure of the copper layer to a nitrogen plasma causes the formation of the copper diffusion layer. Therefore, since Ngo et al. teaches exposure of a copper layer to a nitrogen plasma, it inherently forms a copper diffusion layer as well.

5. Claims 26 and 3 are rejected under 35 U.S.C. 102(e) as being anticipated by 6,251,771 to Smith et al.

In reference to Claims 26 and 3, Smith et al. teaches:

- nitriding/passivating of a copper surface by a nitrogen and methane plasma to convert the surface layer portion into a copper diffusion preventing layer. (See column 3 lines 45-56) The Examiner notes that Applicant only claims that exposure of the copper layer to a nitrogen and methane plasma causes the formation of the copper diffusion layer. Therefore, since Smith et al. teaches exposure of a copper layer to a nitrogen and methane plasma, it inherently forms a copper diffusion layer as well.

6. Claim 4 is rejected under 35 U.S.C. 102(e) as being anticipated by 6,383,925 to Ngo et al.

In reference to Claim 4, Ngo et al. teaches:

- nitriding of a copper surface by a nitrogen and ammonia plasma to convert the surface layer portion into a copper diffusion preventing layer. (See column 4 lines 25-35, column 5 lines 11-21 and column 6 lines 28-51) The Examiner notes that Applicant only claims that exposure of the copper layer to a nitrogen and ammonia plasma causes the formation of the copper diffusion layer. Therefore, since Ngo et al. teaches exposure of a copper layer to a nitrogen and ammonia plasma, it inherently forms a copper diffusion layer as well.

Claim Rejections - 35 USC § 103

7. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

8. Claim 5 is rejected under 35 U.S.C. 103(a) as being unpatentable over 6,335,283 to Ngo et al. in view of 6,174,810 to Islam et al.

Incorporating all arguments of Claim 1 and noting that Ngo et al. fails to explicitly teach exposing the surface of the copper to an ammonia plasma before nitriding the copper layer.

However, Islam et al., in columns 3-4 lines 36-21, teaches exposing a copper surface with an ammonia plasma before placing a copper barrier layer over the copper surface. Furthermore, Islam et al. teaches that the ammonia pre-treatment removes copper oxide from the copper surface which may degrade adhesion of later deposited copper barrier layers.

It would have been obvious to one of ordinary skill in the art to modify Ngo et al. by incorporating the exposure of a copper surface with an ammonia plasma before placing a copper barrier layer over the copper surface, as taught by Islam et al., to remove copper oxide from the copper surface which may degrade adhesion of later deposited copper barrier layers.

9. Claim 7 is rejected under 35 U.S.C. 103(a) as being unpatentable over 6,335,283 to Ngo et al. in view of 6,150,270 to Matsuda et al.

Incorporating all arguments of Claims 1 and 6 and noting that Ngo et al. fails to explicitly teach exposing the silicon containing insulating film to a second nitrogen plasma.

However, Matsuda et al., in column 4 lines 52-65, teaches exposing a silicon film to a nitrogen plasma. Furthermore, Matsuda et al. teaches that the nitrogen plasma nitrides the silicon film into a silicon nitride film.

It would have been obvious to one of ordinary skill in the art to modify Ngo et al. by incorporating the exposure of a silicon film to a nitrogen plasma, as taught by Matsuda et al., to nitride the silicon film into a silicon nitride film.

10. Claim 8 is rejected under 35 U.S.C. 103(a) as being unpatentable over 6,335,283 to Ngo et al. in view of 6,174,810 to Islam et al.

Incorporating all arguments of Claims 1 and 6 and noting that Ngo et al. fails to explicitly teach forming an insulating layer over the silicon containing insulating film, forming a via hole through the insulating layer and the silicon containing insulating layer, burying a plug connected to the copper layer and forming an upper wiring layer connected to the plug.

However, Islam et al. in columns 5-7 lines 10-26 and Figures 1-7, teaches forming an insulating layer over the silicon containing insulating film, forming a via hole through the insulating layer and the silicon containing insulating layer, burying a plug connected to the exposed copper layer and forming an upper wiring layer connected to

the plug. Furthermore, Islam et al. teaches that one would do this to form a copper interconnect structure.

It would have been obvious to one of ordinary skill in the art to modify Ngo et al. by incorporating an insulating layer formed over the silicon containing insulating film, forming a via hole through the insulating layer and the silicon containing insulating layer, burying a plug connected to the exposed copper layer and forming an upper wiring layer connected to the plug, as taught by Islam et al., to form a copper interconnect structure.

11. Claim 12 is rejected under 35 U.S.C. 103(a) as being unpatentable over 6,335,283 to Ngo et al. in view of 6,174,810 to Islam et al. further in view of 6,277,733 to Smith.

Incorporating all arguments of Claims 1, 6 and 8 and noting that Ngo et al. and Islam et al. fail to explicitly teach wherein the insulating film is formed by FSG or porous silicon dioxide.

However, Smith, in column 3 lines 13-30, teaches a dielectric layer formed of FSG that is formed over a silicon containing barrier layer, wherein both layers are etched to expose a copper surface. Furthermore, Smith, teaches that FSG is a good dielectric layer because it has a low dielectric constant.

It would have been obvious to one of ordinary skill in the art to modify Ngo et al. and Islam et al. by incorporating a dielectric layer formed of FSG that is formed over a silicon containing barrier layer, wherein both layers are etched to expose a copper surface, as taught by Smith, to form a dielectric layer that has a low dielectric constant.

Response to Arguments

12. Applicant's arguments with respect to Claims 1, 3-8, 12, 13 and 26 have been considered but are moot in view of the new ground(s) of rejection.

Conclusion

13. Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

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Any inquiry concerning this communication or earlier communications from the examiner should be directed to David L. Hogans whose telephone number is (703) 305-3361. The examiner can normally be reached on M-F (7:30-4:30).

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Carl Whitehead Jr. can be reached on (703) 308-4940. The fax phone numbers for the organization where this application or proceeding is assigned are (703) 308-7722 for regular communications and (703) 308-7724 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is (703) 308-1782.

dh
March 1, 2003


CARL WHITEHEAD, JR.
SUPERVISORY PATENT EXAMINER
TECHNOLOGY CENTER 2800